



Enggrong Modification Reduces Low Back Pain Risk on Sand Workers



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Abstract

Material handling manual work is a job at risk to worker health and safety, errors in the manual procedure of manual material handling will result in health impacts in the short and long term. One of the manual jobs of material handling is the job of lowering the sand from the top of the truck. In working the workers use a tool in the form of enggrong which is a shovel with a short handle. Due to the use of employee enggrong work with a stooped posture. This work posture raises the potential for low back pain on workers. Low back pain is a pain and/or loss of workability as a long-term risk of postural errors in activity. Low back pain occurs on low back disc L4 / L5 or L5 / S1. This study used treatment by the same subject design with a sample of 9 participants. The purpose of the study was to find out the different forces in Low back disc L4 / L5 when the worker worked using standard enggrong (Period 1 / P1) compared to using modification enggorong (Period 2 / P2). The forces in the L4 / L5 Low back disc include 1) compression, 2) anterior/posterior shear, and 3) lateral shear. Work posture data was taken using Microsoft Kinect™ 3D camera and analyzed by using Siemen Jack 3D Static Strength Prediction Program (3DSSPP) method to get the force on the low back disc. The results of the analysis of the 6 work postures P1 and P2, showed a significant decrease ($p < 0.05$) in the average compression force in the low back disc L4 / L5 on the work posture using modified enggrong. Enggrong modification lowers compression in low back disc L4 / L5 by 38.73% (P1 2143.8 ± 411.3 N; P2 1320.2 ± 418.4 N), anterior / posterior shear 46.17% (P1 $542, 6 \pm 103.9$ N, P2 292.1 ± 81.2 N), and lateral shear 29.69% (P1 31.2 ± 22.08 N; P2 16.6 ± 14.28 N) compared with the use of enggrong standard. The threshold value for compression 3400 N and anterior / posterior shear is 700 N, then the compression and anterior / posterior shear values in Period 2 are well below the threshold. Decrease in the press force in low back disc L4 / L5 is as a result of changes in work posture workers who work using modification enggrong. It can be concluded that the use of modification enggrong can decrease the compressive force in the low back disc L4 / L5 so as to reduce the low back pain occurs to the workers.

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1. Introduction

Sand workers are workers who are tasked with removing sand from a truck. In work, the worker uses a short-handed shovel called enggrong. The use of enggrong is widespread in Central Java and Yogyakarta. During the process the sand held, workers, work with a bent posture. The work system of the sand worker is included in manual material handling (Karwowski & Rodrick in Salvendy, 2001) with high rates of occupational disease (Karwowski & Rodrick in Salvendy, 2001; Petersson *et al.*, In Zandin, 2004) and accidents (Bloswick & Sesek in Zandin, 2004; Manuaba, 1998; Sutjana, 2014). Various forms of occupational diseases occur in certain parts of the body such as musculoskeletal disorders (MSDs), back pain disorders (BPDs) (Salvendy, 2001; Zandin, 2004; Violante *et al.*, 2003), repetitive strain injuries (RSIs) repetitive motion injuries (RMI), and cumulative trauma disorders (CTD) (Gilad in Zandin, 2004), cause pain complaints and may also result in loss of ability to work (Violante *et al.*, 2003).

The use of working aids when enggrong work down the sand, causing workers to work with posture bending, this is done because the handle of a shovel is relatively short. Bending posture is very risky cause the potential of low back pain. The Bridger (1998) study showed that the posture of the worker in the soil with the shovel caused the potential for low back pain. Prairie *et al.*, (2016) demonstrated the potential risk of low back pain on paramedic workers using the 3DSSPP program to predict a large force load on L5 / S1.

This study focuses on the forces on the low back disc L4/L5 worker posture when the worker works to reduce sand from the truck using standard enggrong aids and enggrong modification and correlation with low back pain. The forces on low back disc L4/L5 consists of compression, anterior/ posterior shear and lateral shear.

2. Materials and Methods**2.1 Subject**

The subject consists of 9 workers with healthy health status and without disability body. Mean age of subjects (standard deviation) 42.22 ± 8.43 years with work experience 11.11 ± 3.51 years and body mass index of 22.59 ± 09 kg / m² with mean body weight 58.71 ± 4.25 kg and mean height 162.50 ± 5.08 cm.

2.2 Experimental Design

This study uses the *treatment by subject design* with two tools used, namely the standard enggrong commonly used by the worker (Figure 1) and the modification enggrong (Figure 2). Period 1, the subject works with the usual work pattern using standard enggrong without any intervention. Period 2, the subject works by using modification enggrong. Each subject will work using both types of enggrong to reduce the sand load of 5.5 m³ of sand from the truck with unlimited time.

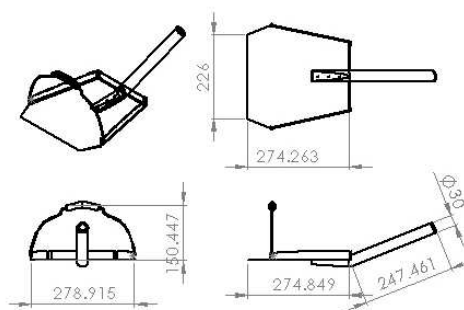


Figure 1. Standard Enggrong Specification

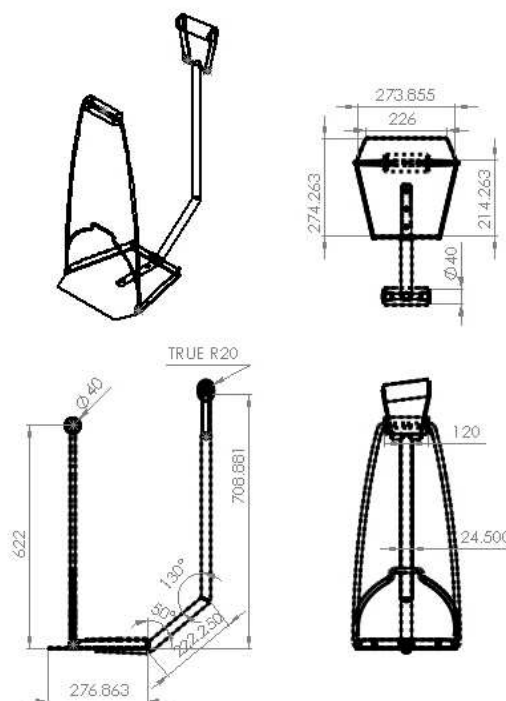


Figure 2. Specifications of modification enggrong

2.3 Data Retrieval and Analysis

Data collection of worker posture is done when worker work. During work worker posture is recorded with 3D camera of Microsoft Kinect™ V1 (Xu & McGorry, 2015), the image of worker's posture is processed and featured Siemen Jack software. The force on low back disc L4/L5 worker posture is predicted with 3D *Static Strength Prediction Program* (3DSSPP) software (Rajae et al., 2015). Worker postures analyzed are postures in a cycle of movement and posture that are often done by workers either using standard enggrong or enggrong modifications.

Statistical analysis using IBM SPSS Statistic 20 software for normality test using Shapiro Wilk normality test and comparative test used t-paired test for normally distributed data while for non-distributed data, Wilcoxon Signed Rank Test was tested. The tested data are compression, anterior/posterior shear and lateral shear on low back disc L4 / L5 for each work post both in Period 1 and Period 2 with significance level $p < 0,05$.

3. Results and Discussions

3.1 Results

The frequent movement cycle of the worker is a cycle of motion that swings sand to the side with the working post analyzed is 6 worker postures in Figure 3 for enggrong standard use and Figure 4 for the use of modification enggrong.

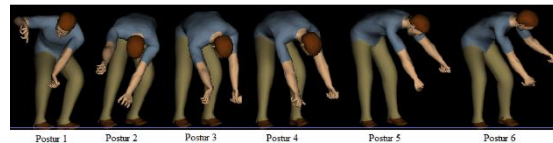


Figure 3. Worker posture Period 1 with standard enggrong

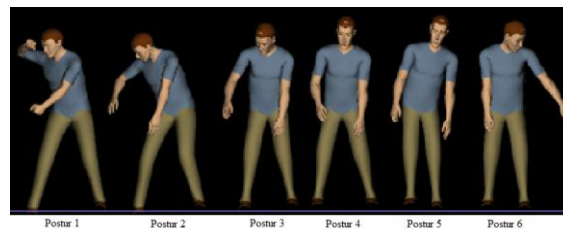


Figure 4. Worker posture Period 2 with modification enggrong

The result of data processing using Siemen Jack software 3DSSPP prediction method obtained the average forces on the low back disc L4/L5 for the 6th posture Period 1: compression 2143.8 ± 411.3 N, anterior / posterior shear 542.6 ± 103.9 N and lateral shear 31.2 ± 22.08 N. The mean force for the 6th posture Period 2: compression 1320.2 ± 418.4 N, anterior/posterior shear 292.1 ± 81.2 N and lateral shear 16.6 ± 14.28 N. The forces compression, anterior/posterior shear and lateral shear for Period 1 and Period 2 are shown in Figures 5, 6 and 7.

Compression, anterior/ posterior shear and lateral shear decrement Period 2 from Period 1 were significant with significant test results ($p < 0.05$) for each posture in Period 1 and Period 2 (Table 1).

3.2 Discussion

Based on the distribution of compression, anterior/posterior shear and shear material in low back disc L4 / L5 Figure 5, 6, and Figure 7, it is seen that the force in the low back disc L4 / L5 Period 2 is lower than in period 1. This indicates changes in the size of the low back disc L4 / L5 as a result of the use of modification enggrong.

The average compression in Period 1 and Period 2 is lower than the compression allowed in manual material handling ie with a limit of 3400 N (NIOSH Limits). The average difference of compression between Period 1 and Period 2 is 823.6 N or Period 2 is lower 38.73% than Period 1. The average compression in Period 1 is lower by 36.46% of the limit given by NIOSH, while the mean compression in the Period 2 lowers 61.17% of the limits provided by NIOSH.

The permissible compression limit of 3400 N is the permissible limit in manual material handling in industrial applications (Harris-Adamson *et al.*, 2016; Milosavljevic *et al.*, 2011; Labaj *et al.*, 2016) although the maximum compression limit is 6000 N (Delleman *et al.*, 2004; Salas *et al.*, 2016).

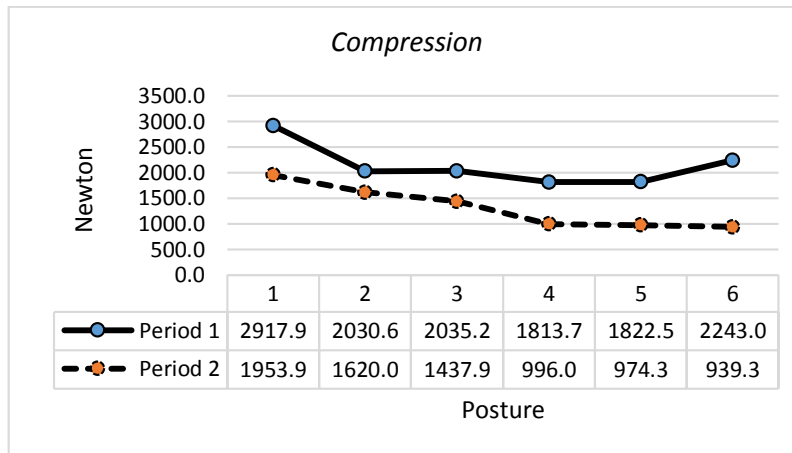


Figure 5. Compression graph on low back disc L4 / L5

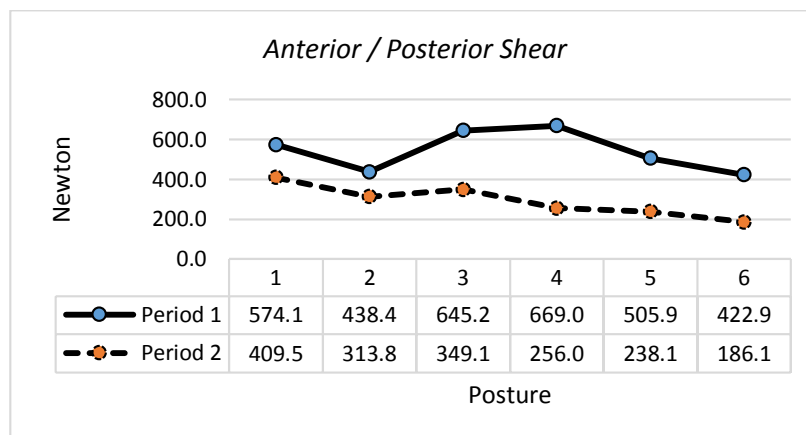


Figure 6. An anterior/posterior shear graph on a low back disc L4 / L5

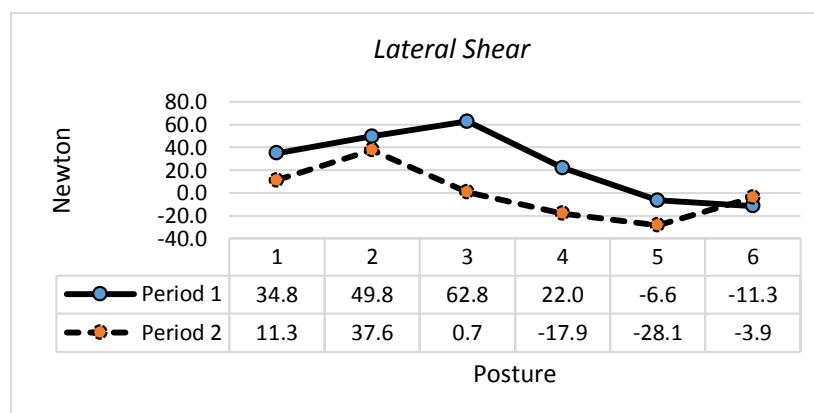


Figure 7. Lateral shear graph on low back disc L4 / L5

Table 1
The results of the comparative force test on
Compression, Anterior / Posterior Shear, and Lateral Shaer

<i>Paired</i>	<i>Compression</i>		<i>AP Shear</i>		<i>Lateral Shear</i>	
	Mean dif	p	Mean dif	p	Mean dif	p
Po1 P1 vs Po1 P2	963,97	0,000 ^a	164,59	0,000 ^a	23,56	0,008 ^b
Po2 P1 vs Po2 P2	410,64	0,000 ^a	124,60	0,000 ^a	12,11	0,000 ^a
Po3 P1 vs Po3 P2	597,32	0,000 ^a	296,09	0,000 ^a	62,01	0,008 ^b
Po4 P1 vs Po4 P2	817,68	0,000 ^a	413,00	0,000 ^a	39,91	0,000 ^a
Po5 P1 vs Po5 P2	848,20	0,000 ^a	267,80	0,000 ^a	21,54	0,000 ^a
Po6 P1 vs Po6 P2	1303,76	0,000 ^a	236,79	0,000 ^a	7,43	0,008 ^b

The value of the significance level of the comparative test is 0.05

a Comparison test t-paired

b Comparison Wilcoxon Signed Rank Test

Po: Posture

The use of the threshold value for anterior / posterior shear with a limit of 700 N for repetitive manual handling material and 1000 N for non-repetitive handling material handling (Gallagar & Marras, 2012) is also used in the study of lifting of patients into the ambulance (Prairie *et al.*, 2014; Labaj *et al.*, 2016). Other studies used the allowable anterior/posterior shear limit of 500 N from McGill (Harris-Adamson *et al.*, 2016) for exciting or encouraging work.

The mean difference of lateral shear between Period 1 and Period 2 is 14.62 N or Period 2 is lower 29.69% than Period 1. Decreasing compression, anterior/ posterior shear and lateral shear in Period 2 have an impact on reducing the risk of low back pain in workers. This decrease in L4/L5 forces as a result of changes in worker posture working with new working tools (modification enggrong). The use of modification enggrong forced workers to work in a neutral posture position, this change impacted the decreasing moment on the trunk and the forces acting on L4/L5. As a result of changes in the worker's posture in the work, the center of workload also changes, closer to the center of the workload at the point of body weight is one of the principles in minimizing the force and moment on L4/L5 for manual material handling work (Kroemer & Grandjean, 2003; Karwowski & Marras, 2003; Karwowski, 2006). This principle is also used by Plamondon *et al.*, (2014) to analyze the weight-shift weight lift process of 15 kg.

4. Conclusion

The use of modified enggrong significantly reduces the risk of low back pain on the worker when working down the sand by lowering the compressive force on a low back disc L4 / L5. To further study whether the modified enggrong is also solid used well when used to raise sand onto a truck.

Conflict of interest statement and funding sources

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Statement of authorship

The author(s) have a responsibility for the conception and design of the study. The author(s) have approved the final article.

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